

## ORIGINAL ARTICLE

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# Developing and validating a checklist for assessing the performance of air ambulance services

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**Abstract:** **Objective:** The purpose of this study was to develop a checklist for assessing the performance of air ambulance services.

**Method:** This is a qualitative study. The first phase involved a review of existing documentation about air emergency standards to create a checklist of the most critical factors and components affecting the performance of air ambulance services. The second phase required experts to complete a performance evaluation checklist from the previous phase. The third phase utilized the Delphi technique to validate the performance evaluation checklist for air ambulance services. The experts in this study were 24 pundits with a vested interest in the subject.

**Results:** A total of 31 items exist in the area of helipad-related facilities, 17 items in the area of process requirements for medical centers with helicopter landing areas, 15 items in the category of human resources for air ambulances, 10 items in the category of human resources for receiving or delivering patients from air ambulances to medical centers, 27 items in the area of base equipment, 17 items in the area of helicopter equipment, and requirements, 14 items in the category of technical, communication, and safety equipment for use inside the helicopter, 10 items dealing with time standards, 11 items dealing with road and urban base requirements for air ambulance operations. Experts approved two items in the area of utilizing other rescue and law enforcement agencies to assist and cooperate with air emergency flights and two items in the area of comfort for conscious patients to alleviate stress during flight.

**Conclusion:** A performance evaluation checklist is an effective tool for evaluating the quantity and quality of emergency helicopter services provided and measuring their performance.

**Keywords:** Air Ambulances; Emergency Medical Services; Health Care Process Assessment; Validation Studies as Topic

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## 1. Introduction

One of the most critical metrics in prehospital emergency care is to expedite attendance at the patient's bedside and shorten the time required to transfer patients from the scene to medical centers. As a result, the tendency to use air ambulances developed long ago in developed and vast countries (1). Helicopter Emergency Medical Services (HEMS) is one of the components of an EMS organization that can assist people in life-threatening situations (2). HEMS is critical in providing prehospital emergency care to patients who live in remote and inaccessible areas with no access to ambulances. Additionally, it is responsible for transporting equipment and personnel to specific domains in the event of a disaster (3). In 2000, the Tehran EMS organization center established the country's first air ambulance, and nearly 40 helicopters are now used in this capacity throughout the country (as of the end of 2021). Because the air ambulance is an expensive as-

set and its use carries inherent risks, standards must be defined to ensure that it is appropriately used (4). Managers are constantly attempting to ensure the effectiveness of health care services and making necessary corrections when necessary. A standard checklist is required to conduct an accurate assessment so that providers can become aware of the current situation and resolve its issues by comparing it to the standard checklist (5, 6). Thus, this study aimed to develop a valid checklist for evaluating the effectiveness of air ambulance services in Iran.

## 2. Methods

### 2.1. Study design

This qualitative study was conducted in Iran between August 2020 and September 2021. This article was adapted from a master's thesis approved by the ethics committee at the School of Health of Shahid Sadoughi Univer-

sity of Medical Sciences in Yazd, Iran, under ethics code IR.SSU.SPH.REC.1399.108.

## 2.2. Participants

Participants were experts in fields related to air ambulance services who were selected from Yazd, Ahvaz, and Khorramabad based on their knowledge and experience, proclivity, and availability for the study.

## 2.3. Checklist preparation

The first step was to review documents about air ambulance service standards to compile a checklist of the most critical factors and components affecting air ambulance service performance. The Persian databases SID, Iran.doc, and Iranmedex and the English databases Scopus and Google scholar (2008-2020) were searched for keywords such as requirements, standards, performance evaluation, air ambulance, and prehospital emergency care (and their Persian equivalents). Several documents were also retrieved from the Iranian Ministry of Health and Medical Education website, while others were provided to researchers by several experts. The next step was for experts to complete a performance evaluation checklist to reach a collective agreement. The experts were asked to provide their input on the proposed checklist's subject area and add their desired items. The experts were provided with a checklist at this stage that included 9 domains and items associated with each area compiled in the first phase.

## 2.4. Checklist validation

The checklist for evaluating the performance of air ambulance services developed in the first and second steps of the study was validated in three phases using the Delphi technique.

Experts were provided with an initial list of items affecting the evaluation of the performance of air ambulance services during the first round of Delphi. They rated each of the domains and items on a 5-point Likert scale (5 being very suitable and 1 being completely inappropriate). The items were validated using the same Likert scale in subsequent rounds.

## 2.5. Statistical analysis

The mean and standard deviation were used to analyze the data (7); however, the researchers determined the numerical value of the mean. The first round confirmed items with an average score greater than 4 and a standard deviation less than 1, rejected items with an average score less than 2, and other items advanced to the second round. Additionally, several items in the first round of Delphi were recommended by experts who advanced to the second Delphi round.

In the second Delphi Round and item scoring, all participants were given the average score assigned to each item in the previous round. All items with an average score greater than 4 were approved, while those with an average score less than 3 were rejected. The remaining items advanced to the

third Delphi round.

Only items with an average score greater than 4 were approved in the third Delphi round, and other items were eliminated.

## 3. Results

This study included 24 experts with a mean age of 43±1 years and a mean work experience of 18±1 years, including 19 males and 5 females. Table 1 summarizes the baseline characteristics of the participants, including their educational field and job title.

### 3.1. Checklist preparation

After evaluating and reviewing relevant sources (1, 8-11), the study's first step identified 9 major domains and their related items, which included the following:

- Required facilities for helipads
- Air ambulance human resources
- Equipment for bases
- Technical, communication, and safety equipment for helicopters
- Road and urban base requirements for air ambulance operations
- Process requirements for medical centers located at helicopter landing sites
- Human resources for receiving or delivering patients in medical centers from air ambulances
- Equipment and requirements for the helicopter's interior
- Time standards

The domains "required facilities for helipads" and "equipment for bases" had the highest number of items identified in this step, with 20 items in each domain. The domains "human resources for receiving or delivering patients in medical centers from air ambulances" and "air ambulance human resources" consisted of the fewest identified items, with two and five items, respectively.

After consulting with experts, the second step included the addition of two major domains:

- Cooperating with and assisting other rescue and law enforcement agencies during air emergency flights (including the Red Crescent, traffic police, road maintenance department, and others).
- Relaxation techniques for conscious patients to alleviate flight-related stress

Additionally, the experts added some items to the other domains. At this stage, the experts added the most items, 13 in total, to the "air ambulance human resources" and "required helipad facilities" categories. After the second step, a checklist with 11 domains and 156 items was created.

### 3.2. Checklist validation

In the first Delphi round, 78 items across 9 major domains of study and approval were approved, and 21 items advanced to the second round. The majority of items approved in this round were in the domains of "base equipment," "re-

**Table 1** Demographic characteristics of experts who participated in this study

No.	Age	Gender	Work experience (years)	Education level	Field of study	Place of work and organizational position
1	50	Female	17	PhD	Health services management	Shahid Sadoughi University
2	28	Female	8	Master's degree	Health services management	EMS organization
3	35	Male	10	Bachelor degree	Medical emergencies	Air ambulances services (Emergency Medical Technician)
4	42	Male	10	Bachelor degree	Medical emergencies	Air ambulances service (Emergency Medical Technician)
5	33	Male	12	Bachelor degree	Medical emergencies	EMS organization
6	40	Male	16	PhD	Health services management	Manager of Shahid Sadoughi Hospital in Yazd
7	50	Male	20	General Practitioner	General physician	Head of Yazd Emergency Organization
8	57	Male	38	Bachelor degree	Aviation expert	Emergency helicopter pilot
9	42	Female	21	Bachelor degree	Nursing	Clinical Supervisor of Shahid Sadoughi Hospital in Yazd (responsible for code 350)
10	45	Female	18	Bachelor degree	Nursing	Supervision Unit Expert of EMS organization
11	40	Male	14	Bachelor degree	Nursing	Air ambulance base commander
12	53	Male	26	General Practitioner	General physician	Yazd Emergency Organization Educational Deputy
13	50	Male	20	General Practitioner	General physician	Medical Director of Shahid Sadoughi University of Yazd
14	53	Male	34	Master's degree	Management	Crow training director and emergency helicopter pilot
15	48	Male	19	Bachelor degree	Crisis Management	Air ambulance base commander
16	52	Male	23	Bachelor degree	Anesthesiologist	Air ambulances services (Emergency Medical Technician)
17	35	Male	15	Bachelor degree	Nursing	Air ambulances service (Emergency Medical Technician)
18	35	Male	12	Bachelor degree	-	Air ambulances services (Emergency Medical Technician)
19	48	Male	27	Bachelor degree	Medical emergencies	Air ambulances services (Emergency Medical Technician)
20	50	Male	28	Master's degree	Nursing	Head nurse of Shahid Rahnemoun Hospital in Yazd
21	30	Male	9	Bachelor degree	Nursing	Responsible for code 350 in Shahid Rahnamon Hospital
22	50	Female	28	Bachelor degree	Nursing	Clinical Supervisor of Shahid Rahnamon Hospital
23	39	Male	15	PhD	Health services management	Shahid Sadoughi University
24	36	Male	5	PhD	Health policy	Shahid Sadoughi University

quired facilities for helipads," and "Equipment and requirements for inside the helicopter," with 19, 15, and 13 items approved in each area, respectively. In the domain "Equipment for bases," 14 of the 19 approved items received the highest score with an average score greater than 4.5. In the domain "Required facilities for helipads," 11 items received the highest score with an average score greater than 4.5, and in the domain "Equipment and requirements for inside the helicopter," 6 items received the highest score out of 13 approved domains (Table 2).

The second round evaluated all items added in the second

stage of the study and those resulting from the first Delphi round. In this round, 75 items were approved across 11 major domains, and only 16 items advanced to the third round. The majority of items in the "Required helipad facilities" and "Air ambulance human resources" domains were approved, with 16 and 14 items, respectively. In the "Required facilities for helipads" domain, 10 approved items received the highest score with an average score above 4.5, while 9 approved items received the highest score with an average score above 4.5 in the "Air ambulance human resources" domain.

Additionally, most items that advanced to the next round

**Table 2** Domains and the total number of items during the three Delphi rounds

Area	Number of items identified via literature review	Round of Delphi (number of items)									Final	
		First			Second			Third				
		approved	entering next round of Delphi	added by experts	The sum of the items entered the second round	approved	entering next round of Delphi	deleted	approved	deleted		
Required facilities for helipads	19	15	4	-	13	17	16	1	-	-	1	31
Process requirements for medical centers located at helicopter landing sites	11	11	-	-	7	7	6	1	-	-	1	17
Air ambulance human resources	5	2	3	-	13	16	13	3	-	-	3	15
Human resources for receiving or delivering patients in medical centers from air ambulances	2	2	-	-	9	9	8	1	-	-	1	10
Equipment for bases	20	19	1	-	8	9	8	1	-	-	1	27
Equipment and requirements for the helicopter's interior	15	13	2	-	3	5	4	1	-	-	1	17
Technical, communication, and safety equipment for helicopters	16	7	9	-	1	10	3	7	-	4	3	14
Time standards	6	3	2	-	5	7	7	-	-	-	-	10
Road and urban base requirements for air ambulance operations	6	6	-	-	5	5	5	-	-	-	-	11
*Cooperating with and assisting other rescue and law enforcement agencies during air emergency flights (including the Red Crescent, traffic police, road maintenance department, and others)	-	-	-	-	3	3	2	1	-	-	1	2
*Relaxation techniques for conscious patients to alleviate flight-related stress	-	-	-	-	2	2	2	-	-	-	-	2
Total	100	78	21	-	69	90	74	16	-	4	12	156

\*These two domains were added according to the experts in the expert panel phase.

in this round are associated with the "Helicopter technical, communication, and safety equipment" category, comprising 7 items (Table 2).

In the third Delphi round, only 4 items in the field of "Helicopter technical, communication, and safety equipment" were eliminated with an average approval score of over 4, and another 12 items were eliminated. Among the deleted items, the item with the lowest average score (2.7) was 1 from the field of "Human resources for receiving or delivering patients from air ambulances in medical centers" (Table 2).

The final validated checklist (Appendix 1) included 11 major domains and 156 items. The majority of the items are related to "required facilities utilizing other rescue and law enforcement agencies to assist and cooperate in air emergency flights" and "relaxation for conscious patients to alleviate stress during flight," each of which consisted of 2 approved items.

## 4. Discussion

According to the study's findings, helicopter facilities are critical because they can significantly impact the performance of air ambulances. One of the study's findings by Alavi et al. was the standards for helicopter landing site facilities (4), which was consistent with the first area of this study's findings (facilities required for the helicopter). According to

the current study's findings, the second area encompasses "process requirements for helicopter landing sites in medical centers." Alavi et al.'s study discussed the standards for helicopter landing locations in medical centers (4).

In the study conducted by Akbari Sari et al. to develop a questionnaire to assess hospital emergency department performance, one of the questionnaire's items was space and physical facilities (12), which corresponds to the second area of the current study. The third and fourth domains of the current study's validated checklist indicate the quantity and type of human resources. Additionally, the study conducted by Aghajani et al. entitled "Review of air emergency services upgrade program in the health system transformation plan: an overview of its background, necessity, results, and challenges" (13) emphasizes the importance of human resources in air emergency upgrades, which aligns with our study's section on human resources.

Moreover, Memarzadeh et al. highlighted the importance of flight crew combination in air transport and the effect of their experience and training on patient outcomes in their research (14). Alavi et al. noted in their study that the composition of an air ambulance crew varies by country, with the presence or absence of a physician among flight staff cited as a reason for this disparity (4). The presence of a physician on the flight crew was not considered mandatory in this checklist. Myers et al.'s in New Zealand also indicated that expert

physicians performed better than those with no experience in inter-hospital transportation (15), highlighting the essential role of a skilled and experienced flight crew. Another aspect of the current study is the scope of "time standards." Given that one of the reasons for using an air ambulance is to shorten the time required to transport injured people to medical facilities, this area is critical. Shojamoradi et al. examined the notification time, response time, stage time, transfer time, rescue time, and total mission time (16). Furthermore, Coughlan et al. discussed the cost-effectiveness of air ambulances compared to ground ambulances, transfer reduction, and treatment time (17). According to Erie et al.'s findings, participation of other organizations in promoting prehospital emergency services at the community level is one of the necessary extra-organizational measures (18), which corresponds to the final two items of the performance evaluation checklist obtained in this study. Moreover, Bayrami et al. stated that collaboration and participation of other organizations such as radio and television stations and traffic policies effectively improve prehospital emergency services at the community level and reduce challenges in prehospital emergency departments (19).

## 5. Limitations

Among the study's limitations are the excessively long data collection process necessitated by the spread of new COVID-19 disease waves and the unwillingness of some officials to cooperate with data collection.

## 6. Conclusion

This study aimed to create a checklist for evaluating the performance of air ambulance services in Iran in 2020-2021. According to the researchers, the domains and items identified and validated in this study can significantly impact the optimal performance of air emergencies, resulting in proper and timely management of emergencies and a reduction in fatalities and irreversible damage from accidents and incidents. Based on the findings of this study and expert consultations, in order to improve air emergency services, greater attention should be paid to the quantity and quality of human resources and their needs, training personnel, increasing coordination between medical centers that receive patients and air emergency, provision of necessary equipment, and periodic evaluation and extraction of defects and provision of solutions to eliminate the defects.

Given that the performance evaluation checklist developed as a result of this study was established in consultation with experts in this field, it is an appropriate tool for evaluating the quantity and quality of emergency helicopter services and measuring their performance. Assessing air ambulance services may aid in the completion and improvement of this study, and it is hoped that this checklist will be used in future studies evaluating the performance of air ambulance services.

## 7. Declarations

### 7.1. Acknowledgment

We wish to express our gratitude to all officials from the Emergency and Air Ambulance Organizations affiliated with Yazd, Khorramabad, and Ahvaz Universities of Medical Sciences, who assisted us in collecting data.

### 7.2. Authors' contribution

Jafari H, Askari R, Kalantarzadeh Z, and Montazeralfaraj R designed the study; Kalantarzadeh Z and Pahlavanpour S collected data; Jafari H, Askari R, and Kalantarzadeh Z analyzed the data; and Jafari H, Askari R, and Kalantarzadeh drafted the manuscript. The final manuscript was read and approved by all authors.

### 7.3. Conflict of Interest

The authors declare no conflict of interest.

### 7.4. Funding

Not applicable.

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## Appendix 1 Final checklist for evaluating air ambulance service performance

Domains	Items
Required facilities for helipads	1) The helicopter landing strip must be a solidly built area at least 9*9 meters in length.
	2) Having a floodlight and a wind indicator light, as well as a flashing revolving light mounted on top of a fabric windshield or flagpole in the form of a 100-watt lamp without the use of a transformer for runway lighting.
	3) The helipad's landing and take-off paths should be in the direction of the wind and be devoid of any extraneous objects such as trees or additional lamps, and the building's sides should be at least 56 meters wide.
	4) Equip obstacles with appropriate lighting.
	5) Existence of firefighting equipment that is easily accessible and visible to the pilot and other personnel.
	6) Compilation of the fire extinguishing process.
	7) The heliport surface should have a dark green, gray, or any other color approved by the organization as the background color, all of which should be dark and not reflect light into the pilot's eyes.
	8) Prohibited flight area (if necessary) due to unauthorized height of obstacles within a 150-degree angle and in the area of the heliport with a red hatch on the surface of the heliport in a suitable location and limited, a width of at least 30 cm and a maximum of 50 cm, 45-degree design.
	9) Install warning signs in desired locations (heliport and helipad), such as no smoking, danger, exit, and traffic.
	10) The surface area of the helipad varies according to its size and location of the helipad. Almost every helipad for a Mile 17 helicopter (including the safety area) must have at least a 50-meter-diameter circle (or 36-meter-diameter circle for a Bell helicopter or similar). If a facility is required, its area should also be considered concerning the helipad's standard distance.
	11) Provide a suitable space for landing.
	12) Write the letter H in the area's center.
	13) Identifying the most secure entry point for the medical team.
	14) Asphalt the area if possible.
	15) Place a vane flag at the pad's edge or a flag that shows the wind direction and speed.
	16) Select the shortest route between the landing site and the emergency department for the patient.
	17) 24-hour free-access route to the hospital.
	18) In-hospital helipad operations, where HLO (Helicopter Landing Officer) deployment is mandatory.
	19) Existence of pad floor lighting standards for night flights.
	20) Area selection devoid of future intentions of constructing a tall structure or planting tall trees.
	21) Installing a fence around the pad at a standard and safe height to prevent unrelated people and vehicles from entering the pad area.
	22) Construction of the pad's main area with reinforcement and concrete of an appropriate tonnage to prevent the pad from being damaged by unexpected events such as earthquakes.
	23) Construction of pads along an appropriate route and slope away from the area's flood path.
	24) Determining the most efficient method of transporting the patient from the hospital at the origin to the destination.
	25) Justification for the patient's companion to observe safety precautions when personnel enters the helicopter.
	26) Rapid patient transfer from the hospital's emergency department to the helicopter by treatment personnel.
	27) Daily inspection of the elevator.
	28) The presence of complete resuscitation equipment and devices adjacent to the stretcher used to transport the patient.
	29) Medical personnel training involving air dispatch events.
	30) The height of obstacles should be considered one meter for every 8 meters away from a helicopter.
	31) Select a location for a helicopter that is a safe distance from residential areas for the public's safety.

## Appendix 1 Final checklist for evaluating air ambulance service performance

Domains	Items
Process requirements for medical centers located at helicopter landing sites	1) Identify the landing pad security team's leader and construct a security ring to keep people and spectators away from the helicopter during the landing.
	2) The hospital supervisor is in charge of the patient's helicopter delivery team and serves as the process coordinator, including coordination with the safety and security team. In medical centers with an emergency supervisor, this is the individual's responsibility, and in the event of their absence, the hospital nursing office will determine their successor.
	3) In medical centers without landing pads or the ability to land, coordination and cooperation with the airbase's manager to determine the location of a helicopter landing, preferably as close to the medical center as possible, as well as coordination with dispatch-police to ensure security.
	4) Defining the air ambulance landing code (350), specifying the team, and installing a table of responsible personnel's names, as well as defining the procedure for contacting them prior to helicopter landing and how to deliver patients while observing safety points.
	5) Forming a team for code 350 entails forming a clinical group and a safety and security group, with the clinical supervisor serving as the team leader.
	6) Daily supervision of the pad by the head of the safety and security group, as well as clarification of responsibilities such as monitoring the cleanliness and objects surrounding the pad and cleaning them to prevent them from being blown around by the wind between group members, prior to and during the helicopter landing.
	7) Presence of clinical group of team 350 with vital and resuscitation equipment next to the pad before landing to deliver and transform the patient and their documents and equipment.
	8) The presence of the 350 team leader (clinical supervisor) adjacent to the helicopter pad from landing to re-flight and exiting the hospital to monitor the performance of the safety and security group and clinical group.
	9) Continuous communication between the clinical supervisor and emergency dispatch to facilitate the necessary coordination and preparation of team 350 (safety and security group and clinical group) prior to a helicopter landing.
	10) Presence of a hospital ambulance adjacent to the helicopter pad to transport injured patients to the hospital emergency room in centers where the distance between the landing pad and hospital emergency department is long, coordinated by the clinical supervisor.
	11) Coordination and oversight of installing a wind vane or flag in a visible location for the pilot to detect the wind direction for helicopter landings by the head of the hospital 350 teams in collaboration with the head of the air ambulance base following code 350 instructions.
	12) Existence of patient-related tools and equipment (e.g., long backboard, belt, guide immobilizer, blanket, and others) to facilitate delivery and avoid time wastage.
	13) Conduct drills frequently to improve coordination.
	14) Coordination between hospitals receiving patients and air emergency personnel.
	15) Monitoring physical factors affecting the helipad runway, such as dust, noise, and light.
	16) Periodic evaluation and extraction of defects and presentation of solutions.
	17) Establish a protocol for identifying patients needing an air ambulance.
Air ambulance human resources	1) 2 nurses or emergency medical personnel trained in AMT (Air Medical Transport).
	2) 1 physician or expert in charge of the base.
	3) 2 to 4 flight crew.
	4) Using consistent personnel for the airbase and refusing to change personnel frequently (due to people's experience in air emergency).
	5) Examining helicopter personnel's physical fitness and mental health.
	6) Assess staff for acrophobia.
	7) Familiarity with flight safety principles.
	8) Adhering to the proper dress code (flight gear).
	9) Existence of a cleaning service for helipads and helicopters.
	10) Trained and skilled service personnel for patient transport.
	11) Existence of agile and physically fit flight engineers.
	12) Appropriate and collaborative education of hospital and air emergency personnel.
	13) Periodic evaluation of service providers' training and abilities.
	14) Enhancing the skills of physicians and other treatment personnel in air ambulances.
	15) The presence of a midwife when required.



## Appendix 1 Final checklist for evaluating air ambulance service performance

Domains	Items
Human resources for receiving or delivering patients in medical centers from air ambulances	1) Safety and Security Group: The head of hospital security (head of the group), the head of hospital services, the person in charge of physical protection, the hospital's police force, and other group members are appointed at the head of the safety group's discretion.
	2) Clinical group: Clinical or emergency supervisor (group leader), emergency shift manager or triage nurse, hospital emergency department nurse, and service personnel.
	3) Complete familiarity between the two groups with safety concerns.
	4) Wind-resisting the patient's mode of transport.
	5) Securing female colleagues' hijab, such as a veil, chador, or hat.
	6) Educating and justifying personnel responsible for receiving patients to ensure their safety when approaching the helicopter.
	7) Preparation of medical equipment used by the receiving staff for the patient.
	8) No additional items to be carried via the receiving staff.
	9) Appropriate attire for hospital physical protection personnel.
	10) Presence of an HLO officer in hospital.
Equipment for bases	1) Air ambulance base with a sufficient environmental space of at least 80 meters to deploy medical and flight teams, preferably adjacent to one another or in two distinct spaces no more than 200 meters apart to facilitate operation and mission coordination.
	2) Establish a wireless link between the dispatcher in the flight operations room and the air emergency base.
	3) Existence of a permanent telephone line connecting dispatch to the airbase.
	4) Existence and installation of a mosaic map in the airbase and flight operations room.
	5) Installing dispatch indicators, implementing the START triage protocol, and displaying START triage cards in the base.
	6) Maintaining a stock of consumables and non-consumable equipment at the base to support helicopter operations.
	7) The officials of Dispatch Air Base and the Emergency Operations Department are required to adjust the airbase's operation plan so that the air ambulance reaches the start stage of flight with a maximum of 3 minutes from the time the mission is notified to the base, and to report this to higher authorities if this does not occur.
	8) Existence of delivery notebooks, air ambulance equipment checklists, Ministry of Health instructions, and a mission logbook.
	9) Existence of indications for dispatching a helicopter and the supervisor's and other dispatch personnel's justifications for doing so.
	10) Installing the decision-making process for dispatching a helicopter as an algorithm and installing it in the operation and guidance room in the shortest possible time by adhering to the principle of agility and speed of action during the decision-making and dispatch process.
	11) Documentation of all air emergency missions from formation to return to base, as well as completion of all discharge, hospitalization, treatment period, and follow-up documents for transferred patients to determine their assignment in the hospital (outpatient and possibly death in hospital, as well as death in helicopter or death before the helicopter arrives at the patient's location).
	12) Coordination of training for the person in charge of the aircraft controller on the ground (Marshaller), as well as familiarity with helicopters and safety tips for hospital staff, particularly service staff, emergency nurses, and supervisors, with the cooperation and coordination of the base, guard, and air security personnel.
	13) Coordination to conduct periodic and continuous workshops and regular coordination meetings between flight operations - flight crew - officials from hospitals receiving or delivering patients, the airbase, and dispatch, with the cooperation and coordination of the airbase's head.
	14) Notifying the hospital's person in charge of code 350 (clinical supervisor) from the moment the helicopter is dispatched to the hospital and maintaining effective and continuous communication with the medical center receiving or delivering patients or injured people, as well as exchanging information with the supervisor about the number of injured, their history, and the required services.
	15) Any helicopter dispatch for purposes other than medical emergencies must be coordinated with the emergency organization's EOC and approved by the emergency organization's air ambulance department.
	16) Receiving reports from the Safety Management System (SMS) and sending incoming messages to the person in charge of the airbase and the head of the provincial emergency after registration in the relevant notebook.

## Appendix 1 Final checklist for evaluating air ambulance service performance

Domains	Items
	17) Using the principle of process agility and rapid decision-making to dispatch helicopters to provide emergency medical services and avoid administrative bureaucracy.
	18) Internet access at the airbase.
	19) Clinical equipment and medicine for airbases.
	20) Existence of a laptop at the airbase.
	21) Existence of GPS device at the airbase.
	22) Possessing flight point coordinates.
	23) Provision of meals for medical and flight personnel.
	24) Maintaining a nest.
	25) Rest area suitable for pilots (one room per person).
	26) Existence of a standard monthly schedule for medical personnel on call on various days of the month.
	27) Installation of security cameras.
Equipment and requirements for the helicopter's interior	1) The helicopter must be equipped with a defibrillator, pulse oximeter, ventilator, and digital sphygmomanometer. All devices must undergo a vibration test to ensure they do not fail due to the vibration caused by a helicopter in flight.
	2) The presence of a mosaic and numbered map of the flight operations area (150 km flight radius) in a helicopter for the flight team's and medical team's use.
	3) The presence of mission forms and accurate documentation of events, times, and vital patient information (air mission form).
	4) Documentation of daily ambulance delivery in notebooks (consumable and non-consumable medical equipment).
	5) Record events, failures, and possible inconsistencies during each mission in a daily report notebook and notify the airbase's commander and dispatch to convene meetings to monitor and improve processes.
	6) Planning issues weekly to improve safety and internal and external coordination, and minutes of meetings are prepared and protected.
	7) Maintaining equipment and drugs required for the patient's cabin.
	8) Maintaining equipment and drugs required for the jambag.
	9) Maintaining necessary equipment and drugs for the reservation bag.
	10) Maintaining necessary equipment and drugs for the delivery bag.
	11) Maintaining a triage bag.
	12) Maintaining a dressing depot bag.
	13) Personal protection equipment.
	14) Existence and maintaining mission registration notebooks in addition to the mission form.
	15) Notifying dispatch of items registered in notebooks for dispatch documentation registration.
	16) Existence of nausea and vomiting packs.
	17) Existence of pillow and blankets for patient comfort.
Technical, communication, and safety equipment for helicopters	1) Protective glasses and sunglasses.
	2) Flying gear and boots.
	3) Ear protectors.
	4) Adjust the emergency dispatch wireless frequency in the helicopter using the helicopter's independent wireless or emergency frequency program.
	5) Using satellite phones to establish communication coverage in blind communication spots.
	6) Utilizing smartphones equipped with the Android or Note operating systems in Air Base and Emergency Dispatch 115 to send predefined messages and transmit regular helicopter locations to dispatch, as well as the ability to take photos and videos and GPS applications.
	7) Existence of two manual wireless devices and two walkie-talkies equipped with a hands-free communication system.
	8) Large waist scissors for cutting belts and leather shoes.
	9) Waist bag to transport sensitive equipment (laryngoscope and others).
	10) Existence of an electroshock device and heart monitor.
	11) Work gloves and helmets.
	12) A hammer to break the glass.
	13) An adjustable stretcher.

## Appendix 1 Final checklist for evaluating air ambulance service performance

Domains	Items
	14) Vehicle wireless communication equipment.
Time standards	1) Response time: the time it takes from the time an emergency center is contacted until a helicopter arrives at the scene of an accident, which is 17 minutes.
	2) Stage time: The time between the helicopter's arrival on the scene and its departure for the hospital, which is 20 minutes.
	3) It is necessary to have an agile air ambulance capable of flying to the patient within 3 minutes of the announced mission.
	4) Transfer time: the time required to travel from the point of departure to the hospital to the point of arrival, which is 9 minutes.
	5) Rescue time or total mission time: the time between contacting an emergency center and arriving at the hospital, which on average is 46 minutes.
	6) The time between notification and take-off is an average of 8 minutes, which is desirable and envisioned.
	7) The time required to arrive at the patient's bedside varies according to the area's geography and the width of the flight radius and is not constant.
	8) Factoring in the weather conditions dispatch.
	9) Between 3 and 8 minutes from the call to dispatch.
	10) Setting the time of patient admission by the hospital.
Road and urban base requirements for air ambulance operations	1) Existence and installation of mosaic maps based on geographical coordinates in base and ground ambulances, training to use the map during an air ambulance call, and directing the air ambulance to the accident scene under the relevant base's responsibility training all personnel to use the map.
	2) All personnel stationed at urban and road bases (particularly road bases) must complete LZO (Landing Zone Officer) training, which covers the fundamentals of helicopter landing site selection, proximity to helicopter and maintenance safety, and familiarity with the fundamentals of AMT.
	3) The head of the relevant base must justify personnel regarding the indications for helicopter recall and how to transport the patient to a helicopter.
	4) Training ground personnel on scene management, providing the possibility of a helicopter landing on the scene, interaction, and cooperation with police and other rescue organizations to ensure the safety and security of helicopter landing.
	5) Existence of a booklet or CD containing LZO and HLO training materials for colleagues to study.
	6) Provision of LZO equipment and deployment in ambulances from the road and urban bases to ensure safety and guide the helicopter, including 2 helmets, 2 batons with lights, 2 ear protection muffs, 2 luminous vests (emergency cover), and 2 protective glasses.
	7) Training for road base personnel on how to properly block the road for helicopter landings and on how to keep spectators a safe distance away from a helicopter.
	8) Possessing a flag in the ambulance and training personnel on posture, with their back to the wind and correctly holding the flag plus Marshall movements.
	9) LZOs must be equipped with a flag or wind vane.
	10) Training ground personnel to send the accident site location on the road via WhatsApp and convert it to geographical coordinates to facilitate the mission.
	11) Existence and training of personnel in using a fire extinguishing capsule.
Cooperating with and assisting other rescue and law enforcement agencies during air emergency flights (including the Red Crescent, traffic police, road maintenance department, and others)	1) Educating and involving other rescue and law enforcement agencies in the HEMS flight process.
	2) The presence of law enforcement officers at the scene of the initial mission's accident to ensure safety during the helicopter's landing.
Relaxation techniques for conscious patients to alleviate flight-related stress	1) Justify and engage with the patient prior to helicopter transfer.
	2) Keep the patient calm when entering the helicopter.